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ABSTRACT

This paper examines author productivity as a function of subject breadth using literature-productive engineers--subject breadth is defined as a measure of an author's tendency to move outside one or more closely allied subject areas within a discipline. Subjects for the study were chosen at random from the 1971 author index of The Engineering Index and were traced through the 1972-74 author indexes, giving the study a four-year time frame. Subject fields were determined by using Subject Headings for Engineering. A correlation of productivity with breadth of subject range produced a significant negative correlation. Possible reasons for this production characteristic are discussed. (Author)

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AUTHOR PRODUCTIVITY AND SUBJECT BREADTH IN ENGINEERING PUBLICATIONS

by

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INTRODUCTION

The phenemon called the "information explosion" has focused a good deal of attention on the seeking, utilization, and dissemination of scientific and technical information. One area in this information transfer sequence has received considerably less attention; however, the characteristics of the individual publication by the individual author. It has been documented how the researcher finds information, in what order he uses it and finally the pathways down which the author sends his contribution. This article inspects the relationship of individual authors' works to each other in an attempt to discover a meaningful pattern of subject breadth. Several studies have previously touched on this subject, the major being a study by Garvey, Lin and Tomita.[1] The findings of this group suggested, among other things, that scientists and technologists tend to publish across subject areas rather than remaining within a defined area and that as productivity increased there was also an increase in the breadth of subjects covered. Their study does not concentrate, unfortunately, on a single discipline; rather, it spans nine separate disciplines. Subjects were attendees at national conventions who were asked to fill out questionnaires concerning their research and publication activities. From this sample a follow-up questionnaire was sent to the individuals inquiring about further publication activity, subject areas of publication and type of

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position held. As previously indicated, the study showed a trend toward increasing subject breadth as productivity was increased.

There are two problems with the study by Garvey, Lin and Tomita. The first centers on the character of the attendee at the national meeting. Those who attend national meetings, by their attendance, evidence a strong interest in the subject field. A strong interest in the subject field should indicate a more than casual interest in the literature of the field, and possibly a higher publication rate for the attendee.

The second problem with the study is the lack of stratification in the sample. Nine disciplines were used with technologists as well as pure scientists placed in the same pool. As has been demonstrated in the literature, the information gathering and dissemination qualities of the two groups are not always compatible.[2] Herner's generalization that "pure scientists are literature dependent while applied scientists are colleague dependent in seeking information," is as succinct as any statement of the differences.[3]

Consistent with Passman's call for "analysis, experiment, and amelioritive action," the intent of this article is to test the finding of Garvey, Lin and Tomita concerning subject breadth and productivity on a group of engineers.[4] A replication of their work is not intended, as different methodology is being employed and this study only touches on a small part of their larger work. Garvey, Lin and Tomita's study was primarily concerned with the continunity of scientific work leading to a comprehensive picture of the dissemination and assimilation of scientific information through different media. This is clearly beyond the scope of this article which is concerned with how the literature-productive engineer

might fit into a model of the dynamic information user as defined by Garvey, Lin and Woolf.[5] They concluded "the major users of scientific information are also the major producers and evaluators of scientific information." Within this context, the present article will attempt to examine the productivity of engineers as a function of breadth across subject fields.

This article is addressed primarily to those in the information technology field. The more clearly the interconnections in the information flow can be seen, the better organized will be the information services to these users. Secondarily, the article is directed to the astute technologist. Use of studies such as this could aid the researcher in identifying potentially fruitful or more acceptable subject areas for investigation and publication purposes.

METHODOLOGY

A literature search was conducted to identify literature revelant to this subject in the library or information science field. There has been no published material since 1965 which has had as its main topic the publication productivity of engineers as it relates to either depth or breadth across subject areas. Of the items checked, the study mentioned previously, by Garvey, Lin and Tomita, was the most promising. Their study reported on a a large number of authors (N=2030) and their productivity by studying three subgroups of the original sample. The major criteria for inclusion in one of the subgroups was continuance of work leading to publication. The first group was composed of all authors who were conducting work in the same area as their most recent publication. The second was formed by all those authors who had previously been working in the same subject area but had abandoned that area and were currently

working in another. The final group was composed of authors who had abandoned working in another subject area without a return to the original area. A fourth group was composed of all authors who were not working in any scientific or technical area for publication purposes. A two-year period elapsed from the time of publication of the original work to the survey of the sample for classification onto one of the groups described.

Garvey, Lin and Tomita's results indicated a trend toward increased productivity with a decrease in continunity of work in the same subject field. A smaller percentage of authors working in the first group submitted and sucessfully published material during the period covered than the second or third group of authors, both of which were characterized by a departure from their original subject fields.

A test of this finding was begun, realizing that differences in methodology between this study and Garvey, Lin and Tomita's study, such as sampling techniques, could well produce major differences in conclusions. The particular finding--there is a positive correlation between the productive researcher and breadth across subject fields--is both a starting place and the hypothesis for this article.

A pilot study was begun to determine adequate sample size. As a result of the pilot study, using a probability level of 0.05 and a tolerance of ±5%, a sample size of 246 would be the minimum requirement. A total of 435 subjects were chosen at random from the author index of The Engineering Index for 1971.[6] The authors were then checked against the author indexes of The Engineering Index for 1972-74, listing the publications for each of the authors for each of the four years. Only those authors who had published

two or more times in the literature were retained for the final sample. From the original sample of 435, 182 (41.8%) were deleted for publishing but once in the literature. Publication for the purposes of this article includes technical reports, journal articles, special publications, and the transactions and proceedings of societies.

The final sample of 253 was then checked for productivity and breadth across subject areas. The subject fields were determined by using The Engineering Index subject heading under which the citation was found. The Engineering Index thesarus, Subject Headings for Engineering, was used to code the subject areas.[7] The considerable time and effort spent compiling The Engineering Index by professional abstractors who are also engineers was the overriding reason for using the subject analysis of The Engineering Index.

Productivity was found by counting each citation and totaling. No weighting was done for multiple authorship. Each author was given full credit for a citation regardless of the number of authors. Each citation carried the same weight whether a technical report or a journal article.

A Pearson product-moment correlation was calculated between the number of citations and the breadth ratio for each author. The breadth ratio was found by dividing the number of subject areas by the number of publications for each author. The correlation r was computed, producing $r = -0.1338$. The negative value indicating a negative correlation between breadth and productivity of authors. A critical-ratio z test was performed to test the significance of the r value, producing $z = 2.12$. Any value greater than 1.96 in the z test is significant at the 0.05 level. These findings suggest the hypothesis is invalid and a correlation exists between depth

in subject areas and productivity of publications in engineering.

DISCUSSION

McGrath and Altman suggested in 1966 that researchers were best able to advance their careers by authoring papers in quantity rather than authoring only one or few quality papers.[8] Perhaps the easiest way to publish is to apply "procedure, task or peices of equipment over and over, introducing new variables or slight modifications of old variables."[9] The literature supports the position, which needs to be noted here, that most engineers have a difficult time keeping current with the literature, much less contributing to it due to the demands of their profession. It is simply easier for the engineer who has a good idea or equipment configuration with which to perform tests on a variety of problems to use the equipment or idea more than once. The fact that the engineer is frequently unable to keep abreast of the cutting edge of research in his field coupled with the tendency of authors to utilize an idea or equipment more than once for publication purposes may account for some of the small breadth ratios found for the authors.

Another reason for the small breadth ratios found for some of the authors could be the diverse nature of the field. Engineering covers a number of areas which are not necessarily interconnected. The chemical engineer will, in all likelihood, not be publishing in electrical engineering subject areas with great frequency. Most of his publications will tend to remain within the bounds of chemistry and chemical engineering.

McGrath and Altman have suggested another reason for a researcher to remain in one subject area rather than publish in diverse areas. Their

reason is best summarized by what could be called territorial imperative. There is a point, argue McGrath and Altman, where the researcher differentiates himself and his research from other groups in the discipline. Each group of researchers can be said to have their own territory. These groups are not tightly sealed units, members come and go, but as a result of this territorial imperative, exchange of ideas becomes less necessary or possible outside the group. This is not unlike Diana Crane's "invisible college" thesis.[10] The inclusive nature of engineering certainly suggests the possibility of segmentation into delineated areas of concentration.

LIMITATIONS

This study is not intended as a replication of the study by Garvey, Lin and Tomita. The intent here is to study the finding that a positive correlation existed between the productive author and breadth across subject areas. The methodology used here is substantially different and could well produce findings bearing little relation to the previous study for comparison.

The time frame used is noteworthy. Garvey, Lin and Tomita used a four-year time span, the same period as is used here. Elsewhere, Garvey, Lin and Nelson report a time sequence of up to 20 months for the production of one journal article in the engineering sciences.[11] This suggests this study is barely within the median of the normal time span for the production of two journal articles. The major criteria for inclusion in this and Garvey, Lin and Tomita's study was a minimum of two publications. The fact the four-year time span could be a critical factor suggests an additional reason for the high attrition rate from the original sample. Other reasons for the high attrition rate could be the large pool of

potential authors being produced by institutions of higher learning and the referee process necessary to manage this pool with limited publication outlets. Also, as has been noted above, the nature of engineering and the difficulty the engineer has in surveying the field, much less adding to that literature, are all possible factors.

The use of The Engineering Index subject analysis could be a critical factor. Due to the employment of engineers in assigning subject catagories, there seems to be little reason to call that analysis into question.

SUMMARY

The findings of this study and the discussion above suggest two things. First, the engineer seems to be attacking the discipline in a well defined and consistent area. Second, the causal factors for this action are not clear and deserve further study. The literature suggests a number of possibilities, but none has been proven in the context of breadth and publication. Finally, the differences between this study and the findings of Garvey, Lin and Tomita need to be explored to determine if they are method-related or suggest a deeper problem.

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NOTES

[1] W. D. Garvey, N. Lin and K. Tomita, "Research Studies in Patterns of Scientific Communication--IV. The Continunity of Dissemination of Information by 'Productive Scientists,'" Information Storage and Retrieval, vol.8, pp.265-276, 1972.

[2] D. C. Marquis and T. J. Allen, "Communication Patterns in Applied Technology," American Psychologist, vol.21, pp.1052-1060, 1966.

[3] S. Herner, "Information Gathering Habits of Workers in Pure and Applied Science," Industrial and Engineering Chemistry, vol.46, pp.228-236, 1954.

[4] S. Passman, Scientific and Technological Communication, Pergamon, Oxford, 1969.

[5] W. D. Garvey, N. Lin and P. Woolf, "The Dynamic Scientific-Information User," Information Storage and Retrieval, vol.10, pp.115-131, 1974.

[6] The Engineering Index, Engineering Index Inc., New York.

[7] Subject Headings for Engineering, Engineering Index, Inc., New York, 1972.

[8] J. E. McGrath and I. Altman, Small Group Research: A Synthesis and Critique of the Field, Holt Rinehart and Winston, New York, 1966.

[9] Ibid. p.87.

[10] D. Crane, Invisible Colleges, University of Chicago Press, Chicago & London, 1972.

[11] W. D. Garvey, N. Lin and C. E. Nelson, "Some Comparisons of Communication Activities in the Physical and Social Sciences," In C. E. Nelson and D. K. Pollock, Communication Among Scientists and Engineers, Heath Lexington, Lexington, Mass, 1970, p.64.